

# Upper Pleistocene and Holocene fossil avifauna from Moleta Cave (Mallorca, Balearic Islands)

Bartomeu SEGUÍ, Cécile MOURER-CHAUVIRÉ &  
Josep Antoni ALCOVER

## SHNB



SOCIETAT D'HISTÒRIA  
NATURAL DE LES BALEARS

Seguí, B., Mourer-Chauviré, C. & Alcover, J.A. 1997. Upper Pleistocene and Holocene fossil avifauna from Moleta Cave (Mallorca, Balearic Islands). *Boll. Soc. Hist. Nat. Balears*, 40: 223-252. ISSN 0210-260X. Palma de Mallorca.

The assemblage of fossil birds from Moleta Cave (Muleta Cave) is described. The site was discovered in 1962 and excavated by Waldren (1982). Paleontological materials covered a range from 32,000 to 2,000 years b.p. At the time of the excavations, bird remains were not studied. Between 41 and 50 avian taxa have now been recognized. Seventeen are new for the gymnesic fossil record (*Branta/Anser*, *Alectoris* cf. *rufa*, *Alauda arvensis*, *Anthus pratensis*, *Phoenicurus ochruros*, *Saxicola rubetra*, *S. torquata*, *Oenanthe oenanthe*, *Sylvia* cf. *sarda*, *Sylvia* sp. cf. *S. melanocephala/curruca*, *Ficedula hypoleuca*, *Passer* sp. cf. *domesticus/hispaniolensis*, *Petronia petronia*, *Carduelis chloris*, *Tadorna* sp., *Calandrella* sp., *Phylloscopus* sp. and *Sturnus* sp.). Six of them are also new for the insular Mediterranean. In contrast with Upper Pleistocene avifaunas of other Mediterranean islands, passerines are extremely abundant while procellariiforms and birds of prey are underrepresented. Unfortunately, available stratigraphic data do not allow strong conclusions on the colonization of the island by anthropic fauna in the Holocene. **Keywords:** Moleta Cave, Mallorca, Upper Pleistocene, Holocene, paleornithology.

AVIFAUNA FÒSSIL DEL PLISTOCÈ SUPERIOR I HOLOCÈ DE LA COVA DE MOLETA (MALLORCA, ILLES BALEARS). L'objectiu d'aquest treball és donar a conèixer el registre aviar fòssil de la Cova de Moleta. El jaciment fou descobert el 1962 per Waldren (1982). Els materials paleontològics continguts enregistren un període de temps comprès entre els 32.000 i 2.000 anys A.P. Rere l'excavació, els materials paleornitològics romangueren sense estudiar. En el moment actual, entre 41 i 50 tàxons aviaris han estat determinats. 17 són nous per a les Gimnèsies (*Branta/Anser*, *Alectoris* cf. *rufa*, *Alauda arvensis*, *Anthus pratensis*, *Phoenicurus ochruros*, *Saxicola rubetra*, *S. torquata*, *Oenanthe oenanthe*, *Sylvia* cf. *sarda*, *Sylvia* sp. cf. *S. melanocephala/curruca*, *Ficedula hypoleuca*, *Passer* sp. cf. *domesticus/hispaniolensis*, *Petronia petronia*, *Carduelis chloris*, *Tadorna* sp., *Calandrella* sp., *Phylloscopus* sp. and *Sturnus* sp.). D'aquests, sis són també nous per a la Mediterrània insular. A diferència del que succeeix en altres illes del nostre marc geogràfic, els passeríformes són extremadament abundants, mentre que els procel·laríformes i els rapinyaires estan poc representats. Malauradament, tot i que el jaciment enregistra un període de temps estens, les dades estratigràfiques no permeten extreure massa conclusions sobre la colonització de l'illa per la fauna antròpica durant l'Holocè.

**Paraules clau:** Cova de Moleta, Mallorca, Plistocè Superior, Holocè, paleornitologia.

Bartomeu SEGUÍ, Departament de Ciències de la Terra, Universitat de les Illes Balears, Carretera de Valldemossa km 7,5, E-07071 Ciutat de Mallorca. Cécile MOURER-CHAUVIRÉ, Centre de Paléontologie Stratigraphique et Paléoécologique. CNRS, UMR 5565, Université Claude-Bernard, Lyon-I. 27-43, boulevard du 11-

*Novembre- 1918, 69622 Villeurbanne Cedex. France. Josep Antoni ALCOVER, Institut Mediterrani d'Estudis Avançats-CSIC-UIB. Carretera de Valldemossa km 7,5, E-07071 Ciutat de Mallorca.*

*Recepció del manuscrit: 18-nov-97; revisió acceptada: 1-des-97.*

## Introduction

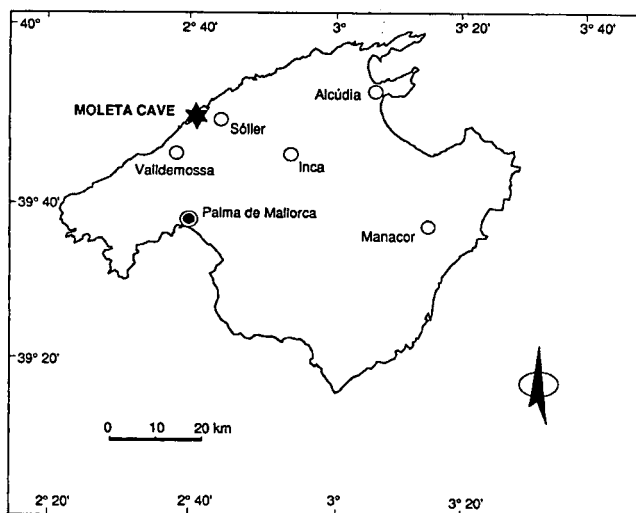
Moleta Cave was discovered in 1962 and intensively studied, along with Abric de Son Matge, as part of a doctoral dissertation (Waldren, 1982). The latter discusses the excavation process, and presents and interprets the numerous paleontological and specially archeological data collected. Nevertheless, most of the fossil microfauna was ignored. The author was aware of the relevance of this remains and at the time considered their possible future analysis (Waldren, 1982).

The present contribution is based on avian material found amongst the vertebrate microfauna. This was partly examined by Dra. Cécile Mourer-Chauviré and some determinations were published by Alcover *et al.* (1981). Most of the material, however, remained unpublished. We herein report on the fossil ornithofauna from Moleta Cave.

of Sóller (Fig. 1). The cavity is a karst dissolution system which has developed in Jurassic materials. The galleries are disposed on two superposed levels connected by a vertical pitfall (Fig. 2). Most of the excavated sectors are in the lower part of the cave. The upper part, where one finds the only two openings, both of which are small, consists of a horizontal gallery. 7 m from the main entrance is the chimney which has a vertical drop of 3 m. As discussed further below, this structure is important for understanding the taphonomic pro-

## Localization and description

Moleta Cave is in the Serra de Tramuntana, in the municipality



**Fig. 1.** Location of Moleta Cave (Mallorca, Balearic Islands).  
*Fig. 1.* Localització de la Cova de Moleta (Mallorca, Balears).



esses which gave rise to the fossiliferous deposit.

### **Chronostratigraphy and age of the materials**

The Moleta Cave displays a continuous stratigraphic series of ca. 10<sup>5</sup> years (Waldren, 1982). Various periods have been characterized on the basis of stratigraphic, paleontological and archaeological data. The *Presettlement Period* (32,000-7,000 b.p. *sensu lato*, up to level 7; Waldren, 1982: 43) includes most of the avian material, although some belongs to the oldest part of the *Early Settlement Period* (7,000-2,000 b.p. *sensu lato*, level 7 and 6), where human presence in the cave is first recorded. The material studied herein is however problematic, as the correlation between the artificial levels determined by fossil extraction with the natural ones described by Waldren (1982) is not clear. The artificial levels contain sedimentary layers up to 1 m thick, and there are no data on the dip of the strata. Hence, the great caution which the valuable information gleaned from datations at specific points must be interpreted. An approximated age has been estimated for the excavated materials (Table 1). We consider O 100-150, CD 100-150 and E 100-150 coetaneous with Man, while Z 700 and Z 750 appear to be prehuman, with an antiquity close to 30,000 years b.p. E 150-250, X 200, X 200-300 and Z 200-300, theoretically prehuman, contain anthropic fauna. Remains of *Apodemus sylvaticus* have been recovered, and other workers also describe anthropic remains in other sectors at ca. 200 cm (F 200, O 200; Adrover, 1966). We suggest from this that the lower layers of E 150-250, which correspond to the upper ones of

X 200-300 and Z 200-300, are those which register the arrival of anthropic fauna. The lower ones of the latter two levels appear to be prehuman and ca. 15,000 years old.

For a parallel discussion on chronological and stratigraphic problems of Moleta Cave, see Marcus (in press).

### **Sediment deposition and taphonomy**

There are useful data on the taphonomy and sedimentology of the fossiliferous deposit. On the basis of geochemical data and paleomagnetic datation, C<sup>14</sup> and racemization of aspartic acid, it is known that sediment deposition started during the Riss Glaciation, 230,000 years b.p. Nevertheless, the main accumulation took place ca. 80,000 years b.p. The fossil remains of *Myotragus balearicus* were deposited mainly during the last 32,000 years (Waldren, 1982).

The physical structure of the cave seems to be of major importance for explaining the recovery of a large number of specimens of *M. balearicus*. 7 m from the opening believed to be the main entrance, the gallery connects with a natural well 3 m deep. The small diameter of the opening and of the gallery interfere with the access of light and probably animals fell in it once they had entered the cave (Waldren, 1982). This sort of natural trap has also been recognized at other sites (e.g. Cueva del Viento, Tenerife; Rando & López, 1996). One may see a parallel situation in volcanic tubes, where vertebrate remains tend to accumulate, and which in fact are key sites for knowledge on oceanic paleocomunities worldwide (e. g. Olson & James, 1991; James & Olson, 1991; Rando, 1995; Rando & López, 1996).

Here light conditions vary on a longitudinal axis and visibility drops with the distance to the opening. A critical point is recognized, from which visibility is nil (Fiol, 1996). From here onwards, one finds most of the fossil remains, belonging to individuals which have lost their orientation. Thanks to its tri-dimensional structure, the Moleta Cave reproduces, at small scale, the conditions in volcanic tubes, which take place in one direction over hundreds or thousands of meters.

## Material and methods

The fossil material referred to herein is kept at the vertebrate collection "Museu de la Naturalesa de les Illes Balears" (acronym MNCM).

For its determination, material has been matched with present-day skeletons in the same collection. Specimens from the United States National Museum (Natural History; USNM) have also been compared.

In the case of non-passeriforms, all skeletal elements have been studied except ribs and vertebrae. With regard to passeriforms, usually only the cranium, humerus, coracoid and tarsometatarsus have been studied. The rest of the postcranial generally lacks characters of enough diagnostic value (Weesie, 1988). The anatomical terminology follows Baumel (1979). Terms used by Howard (1929) are sometimes used. The measurements referred to herein were taken with a caliper graduated to 0.05 mm, as in Seguí (1997, see this volume).

From a geographic point of view, Gymnesic Islands refer to Mallorca and Menorca, while Balearic Islands includes both Gymnesic and Pityusic Islands.

After determination of each taxon, there is a brief reference to the present status of the species in the Balearic

archipelago (data from GOB 1996, 1997), as well as its fossil record in the Western Mediterranean islands. The minimum number of individuals (MNI) present at the fossil site is given for each species, corresponding to the maximum number of skeletal elements from the same side of the body registered.

## Systematic paleontology

Order ANSERIFORMES

Family ANATIDAE

*Branta/Anser*

MATERIAL: O 100-150: MNCM 2658, medial fragment of radius. MNI= 1.

It is very difficult to differentiate between the radii of *Anser* and *Branta* (Miller, 1937; Woolfenden, 1961; Olson & James, 1991). The bone belonged to an adult animal, and its shaft diameter (WD=3,60) fits well within the range found in *B. bernicla*, while it is rather smaller in comparison with *B. leucopsis* (Bacher, 1967). Nevertheless, important similarities were stated with material we were able to examine belonging to a possible new Anserini from Eivissa (Ibiza). The description of this material (McMinn, in prep.) is not yet finished, thus strong conclusions on the material discussed may not be stated.

Genus *Tadorna*

*Tadorna* sp.

MATERIAL: X 200-300: MNCM 47050, fragmented synsacrum. MNI= 1.

This fossil belongs to a middle-sized Anatidae. Important similarities stand out both with *Tadorna tadorna* and *Anas platyrhynchos*, the biggest species in the genus. Despite of the synsacrum being fragmented, it is clearly seen that the ridge that originates in the *Extremitas cranialis synsacri* and extends ventrally

through the *Corpus vertebrae* of the toracic vertebrae reaches at least the second one. This situation is also present in all *T. tadorna* examined. Against this, in *A. platyrhynchos* the ridge reaches just the first vertebra. The size of the fossil is slightly bigger than the latter species, fitting better with *T. tadorna*. It has been impossible to examine any skeleton of *T. ferruginea*, and thus the material is attributed to *Tadorna* sp.

This is the first record of the taxon for the Gymnesic Islands. *T. tadorna* has also been found in the Pleistocene of Corsica (Alcover *et al.*, 1992). Nowadays, both *T. tadorna* and *T. ferruginea* are rare in the Balearic Islands.

Order GALLIFORMES  
Family PHASIANIDAE  
Genus *Alectoris*  
*Alectoris* cf. *rufa*.

MATERIAL: CD 100-150: MNM 2922, distal fragment of right radius; O 100-150: MNM 2651, distal fragment of right radius; MNM 2652, distal fragment of right tarsometatarsus. MNI= 2.

*A. rufa* seems not to be autochthonous in the Balearic Islands, being absent from all prehuman insular Mediterranean faunas (Alcover *et al.*, 1992). Its introduction in Mallorca is first documented for the XIV century (Ferrer *et al.*, 1986).

The MNM 2922 fragment shows some incisions which seem to have been made with a sharp tool. All materials from CD 100-150 and O 100-150 sectors seem to belong to the level 7 ("Early Settlement Period Horizons", Waldren, 1982) from which some datings are available: SM54 (O175)= 3985 b.c.+/- 109 years; SM56 (O150)= 5185 b.c.+/- 80 years and SM57 (O150)= 6620 b.c.+/- 350 years (Waldren, 1980). If these stratigraphic

data is correct, the material proves its presence in the island long before historical introductions.

It cannot be excluded that the remains belong to other circummediterranean species of the genus *Alectoris*, for example *A. barbara* (Bonnaterre), *A. graeca* (Meisner) and *A. chukar* (J. E. Gray), with whom comparison was not possible. In fact, any of them could have been introduced in the Balearic Islands in the past (Blondel, 1987).

Genus *Coturnix*  
*Coturnix coturnix* (L.)

MATERIAL: Sector CD 100-150: MNM 41005, right tarsometatarsus. MNI= 1.

These remains were obtained from the first human occupation levels. A close form was found in the Gymnesic Islands from Plio-Pleistocene and Lower Pleistocene sites (Alcover *et al.*, 1981). Nowadays *C. coturnix* is a summer visitor as well as migrator in the Balearics, being partially sedentary in Mallorca.

Order GRUIFORMES  
Family RALLIDAE  
Genus *Porzana*  
*Porzana porzana* (L.)

MATERIAL: AB: MNM 2951, distal fragment of right humerus; MNM 2482, distal fragment of left metacarpus; Z 200-300: MNM 47056, proximal fragment of right metacarpus; MNM 47057, proximal fragment of left coracoid. MNI= 1.

In spite of the fragmentary state of the remains, they share all features with *Porzana porzana*. A close form was found in Pedrera de S'Ònix (Alcover *et al.*, 1981), from the Pliocene-Pleistocene boundary. The species was also recovered in Crete (Weesie, 1988) and in Corsica (Alcover *et al.*, 1992). The actual status of the species in the Balearic

Islands is unknown, being established populations at least in winter and during migration.

Order COLUMBIFORMES

Family COLUMBIDAE

Genus *Columba*

*Columba* sp. cf. *C. livia* Gmelin/oenas L.

MATERIAL: X 200-300: MNCM 47052, fragmented left tibiotarsus; MNCM 47053, fragmented radius; MNCM 47054, medial fragment of coracoid. MNI=1.

The fossil material, despite being fragmented, is clearly attributed to the genus *Columba*. Its size is smaller than *C. palumbus*. It is difficult to differentiate between *C. livia* and *C. oenas* (Fick, 1974; Weesie, 1988) and almost impossible with this poorly preserved fossil material. *C. livia* was recorded in three Upper Pleistocene sites in Mallorca (Florit & Alcover, 1987a; Alcover et al., 1992) and, as well as *C. oenas*, in other Mediterranean islands (Alcover et al., 1992). Nowadays *C. livia* is common in the Gymnesic Islands, *C. oenas* being rather rare.

Order STRIGIFORMES

Family TYTONIDAE

Genus *Tyto*

*Tyto alba* (Scopoli)

MATERIAL: O 100-150: MNCM 2669, fragmented right tarsometatarsus; CD 100-150: MNCM 47055, left tibiotarsus; Z 200-300: MNCM 47051, proximal fragment of right coracoid. MNI= 1.

The fossil material shares all osteological diagnostic features with the living species. The tibiotarsus MNCM 47055 shows juvenile characters. *Tyto alba* was found in three other Holocene sites in the Gymnesic Islands (Mourer-Chauviré et al., 1977; McMinin & Alcover, 1992). In Moleta Cave, remains of this

species were exhumed from the first human occupation levels (Waldren, 1982). There is so far no preholocenic evidence of the species in the archipelago.

Family STRIGIDAE

Genus *Otus*

*Otus scops* (Linnaeus)

MATERIAL: E 150-250: right radius. MIN= 1.

This complete radius is identical to those of *Otus scops*. The species has also been recorded in two other fossil sites in Mallorca (Ballman & Adrover, 1970): Pedrera de S'Ònix (Pliocene-Pleistocene boundary) and Cova de Son Bauçà (Middle Pleistocene). It seems to have been a common element of Pliocene and Pleistocene Mediterranean insular avifaunas (Alcover et al., 1992). Nowadays it is widespread in the Balearics.

Genus *Athene*

*Athene noctua* (Scopoli)

MATERIAL: Z 200-300: MNCM 2667, distal fragment of right coracoid; MNCM 2666, fragmented left coracoid, MNCM 2668, proximal fragment of scapula; AB: MNCM 2969, medial fragment of left humerus. MNI= 1.

The coracoid of *A. noctua* and *O. scops*, the smaller Western Palearctic Strigidae can be differentiated due to the bigger *Processus procoracoideus* in the former species, as well as for its wider and more angular *Facies articulari clavicularis* in the latter. The coracoid of *A. noctua* is generally more strongly built and rather bigger than that of *O. scops*.

The scapula of *O. scops* is more slightly built and its *Corpus scapulae*, especially at the *Extremitas caudalis*, is more rounded. Humeri of both species

differ in size, *A. noctua* being bigger. On this basis, the medial fragment, has been attributed to this species.

*A. noctua* is not present nowadays in the Balearic Islands. The remains from Moleta Cave are the first evidence of the species in the Gymnesic Islands, the material cited by Alcover *et al.* (1992) being in fact the one described herein. The species has also been found in other insular Mediterranean fossil sites (Alcover *et al.*, 1992). In Crete (Weesie, 1988) the genus *Athene* evolved into an endemic form, *A. cretensis*, developing a larger size, longer legs and shortened wings. On the other hand, remains from the Moleta Cave are identical to modern *A. noctua*.

#### Order APODIFORMES

##### Family APODIDAE

##### Genus *Apus*

*Apus* sp. cf. *A. apus* L. /*pallidus* Shelley

MATERIAL: Z 200-300: MNM 2653, left ulna. MNI= 1

Although comparison with *Apus melba* was not possible, this species can be excluded due to its larger size (Florit & Alcover, 1987a). *A. affinis* is also excluded because of its smaller size. Osteology *per se* is close to that of the remaining congeneric species. Features of the fossil ulna are similar to those of *A. apus*, but the bone is rather stouter. *A. pallidus* cannot be excluded due to the lack of a large comparative series. Morphology of both species proves to be similar (Weesie, 1988) and thus the fossil ulna is attributed to *Apus apus/pallidus*.

The cited material is the first record for the Gymnesic Islands, the citation of Alcover *et al.* (1992) being the bone described in this work. Some other Pleistocene remains of the taxon were

found in Eivissa and Karpathos (Alcover *et al.*, 1992; Sondaar *et al.*, 1995). Nowadays *A. apus* is a common summer visitor in the Balearics. *A. pallidus* is a rather rare summer visitor and migrant.

#### Order PICIFORMES

##### Family PICIDAE

##### Genus *Jynx*

*Jynx torquilla* L.

MATERIAL: O 100-150: MNM 2622, Distal fragment of right tarsometatarsus. MNI= 1.

The tarsometatarsus of *Jynx torquilla* is easily recognized due to the large, well developed *Troclea metatarsi IV*, the remaining woodpeckers being excluded due to the larger size.

Blondel & Frochot (1976) and Blondel (1982) consider *Jynx torquilla* as a typical element of some modern Mediterranean insular avifaunas. It is present nowadays in the Balearic Islands, but has never been found as a fossil species in any other island on the Mediterranean.

#### Order PASSERIFORMES

##### Family ALAUDIDAE

##### Genus *Calandrella*

*Calandrella* sp.

MATERIAL: MNM 47006, MNM 47007, distal fragment of rostrum. MNI= 2.

The rostrum of Alaudidae possesses a *Crista tomialis* that narrows at the anterior end of the narial openings (Moreno, 1985). Both in *Calandrella* and in *Melanocorypha*, narial openings are round and smaller in proportion to the size of the beak, and the *Processus dorsonarialis* and the whole rostrum is stouter than in the remaining genera in the family. Comparison with a single



specimen of *M. calandra* was enough to discard this species, much larger than fossil remains. Coincidence of features and size with *Calandrella* species was high, but not full. A more developed bony ridge ventrally to the *Processus dorsonarialis* and the general thoroughness of the fossil material are the main differences. In spite of this, attribution to this genus is attempted.

No other record of this taxon is known so far for the Balearic Islands.

#### Genus *Alauda*

##### *Alauda arvensis* Linnaeus

MATERIAL: Z 200-300: MNM 2623, right humerus; MNM 2631, MNM 2630, left humerus; MNM 2633, proximal fragment of left coracoid; MNM 2634, right coracoid. MNI= 1.

Jánossy (1983) characterized the humerus of Alaudidae by having a unique, pneumatized depression in the proximal epiphysis, the *Fossa pneumoanconaea*. In the distal epiphysis, the *Processus supracondylaris dorsalis* is weakly developed. All these features are shared by the exhumed bones. Within the group, species distinction can be done merely on size (Jánossy, 1983).

The coracoid of Alaudidae is also well defined due to the *Foramen pneumaticum*, located at the ventral surface of the proximal epiphysis. The *Spina lateralis* is lacking and the *Processus lateralis* is heavily developed (Moreno, 1985). *Lullula arborea* and both *Calandrella* species are smaller than fossil coracoids while *Galerida cristata* and *G. teklae* differ from the fossil material in their larger size, as well as in the different shape of the proximal epiphysis, in which the weakly developed *Facies articularis clavicularis* is a main feature. Coincidence of characters with *Alauda arvensis* is full.

*Alauda arvensis* has never been found in a Gymnesic site before. It was recorded in Eivissa (Alcover et al., 1992; Sondaar et al., 1995). Nowadays the species is a common winter visitor and migrant in the Balearic Islands.

#### Alaudidae sp.

MATERIAL: E 150-250: MNM 2624, right humerus; MNM 2626, proximal fragment of humerus.

Some poorly preserved material has been attributed to the family Alaudidae.

#### Family MOTACILLIDAE

##### Genus *Anthus*

##### *Anthus pratensis* (Linnaeus)

MATERIAL: O 100-150: MNM 2659, right humerus. MNI= 1.

All features described by Jánossy (1983) to define the family Motacillidae are shared by the fossil humerus. Comparison with *Anthus* and *Motacilla* species proves that the material should be assigned to the first taxon due to the development and position of the spine located between the diaphysis and the *Processus supracondylaris dorsalis*. In *Motacilla* the spine is sharp and long, and is located in the middle of the angle between the diaphysis and the processus. In *Anthus* it is a rather rounded tuberculum (in some cases slightly elongated) placed on the processus. Inside the genus, the humerus was compared with *A. campestris*, *A. spinoletta*, *A. trivialis*, *A. berthelotii* and *A. pratensis*, being attributed to the latter mainly on biometric criteria (Moreno, 1986).

The cited material is the first of the species for both the Gymnesic archipelago and for the rest of the Mediterranean islands. Nowadays *A. pratensis* is common in winter and during migration in Mallorca.

Motacillidae sp.

MATERIAL: O 100-150: MNCM 2660, proximal fragment of left humerus; Z 200-300: MNCM 2684, MNCM 47099, proximal fragments of right humeri; MNCM 2685, proximal fragment of left humerus. MNI= 2.

These four fragmented humeri lack features for a specific attribution, and are referred to just family level.

Family HIRUNDINIDAE

cf. *Hirundo* sp./ *Ptyonoprogne rupestris* (Scopoli)

MATERIAL: Z 200-300: MNCM 2942, proximal fragment of left ulna. MNI= 1.

The fact that osteology of the Hirundinidae is well defined (Moreno, 1986) enabled the determination of this ulna, while for the rest of the small Passeriformes this skeletal element was not studied.

*Riparia riparia* and *Delichon urbica* were excluded because of their smaller size. Comparison with *H. daurica* was not possible, and distinction between *P. rupestris* and *H. rustica* very difficult (Moreno, 1986). The fossil bone may belong to either of these species.

Only *P. rupestris* has been recovered in the Gymnesic Islands (Florit & Alcover, 1987a) but almost all living species have been found on other Mediterranean islands (Alcover *et al.*, 1992).

Nowadays there are both sedentary and migratory populations of *P. rupestris* in the Balearics, while *H. rustica* is a summer visitor. *H. daurica* is also seen in summer, but it seems to be rather scarce.

Family PRUNELLIDAE

Genus *Prunella*

*Prunella modularis* (Linnaeus)

MATERIAL: AB: MNCM 47009, distal fragment of rostrum. MNI= 1.

The premaxilla in *Prunella* is characterized by a *Processus dorsonarialis* which bends upwards at the distal end of narial openings. This feature is also shared by some *Anthus* species as well as by some Muscicapidae (Moreno, 1986), but in both cases the bill is more slender. Although comparison with *Prunella collaris* was not possible, this species may also be excluded due to its larger size (Moreno, 1987).

*P. collaris* was cited from two other gymnesic fossil sites: the Cova Nova (McMinn & Alcover, 1992) and the Pedrera de S'Ònix (Mourer-Chauviré *et al.* 1977). There are no fossil records of the species on the remaining Mediterranean islands. Nowadays the species is a winter visitor and migrant in the Balearics.

Family TURDIDAE

Genus *Erithacus*

*Erithacus rubecula* (Linnaeus)

MATERIAL: E 150-250: MNCM 2615, left humerus; Z 200-300, MNCM 2739, MNCM 2740, MNCM 2741, MNCM 2742, left humeri; MNCM 2743, proximal fragment of left humerus; CD 100-150: MNCM 2939, proximal fragment of right humerus; O 100-150: MNCM 2725, proximal fragment of right humerus; MNCM 2726, proximal fragment of left humerus; AB: MNCM 2962, left coracoid. MNI= 7.

In the humerus of *Erithacus* and *Luscinia*, the *Fossa tricipitalis* is less developed than in the remaining small-sized Turdidae and Muscicapidae (Jánossy, 1983). In *Muscicapa striata*, the proximal epiphysis is stouter and

more quadrangular, the *Crista pectoralis* more prominent, with a straight edge. *Ficedula hypoleuca* may show, in a few cases, a weak *Fossa tricipitalis* and some *Erithacus* a rather developed one, differentiation being difficult. The smaller size in *F. hypoleuca*, in spite of some overlap of humerus length for some individuals (Moreno, 1987), enables a correct attribution in most cases.

Distinction between *Erithacus* and *Luscinia* is difficult due to the similar humeral morphology showed by both species. In spite of this the proximal edge of the *Fossa tricipitalis* is elongated in *Luscinia*, and the *Caput humeri* flattened and wider than *Erithacus rubecula* (McMinn & Alcover, 1992). The general proportions of the humerus of *Luscinia* are also slender.

The unearthed coracoid is slightly built, with a well developed, curved *Facies articularis claviculæ* and a *Facies articularis humeralis* which defines a shallow groove at the junction with the proximal epiphysis. These characters are also shared with small Turdidae and Muscicapidae. *M. striata* can be excluded due to the always well developed *Angulus medialis*, possessing a dorsal, three-dimensional spine which joins the

diaphysis by a bicrenated crest, defining a groove (Fig. 3). This situation never happens in *E. rubecula*, which shows a pointed and generally reduced *Angulus medialis*.

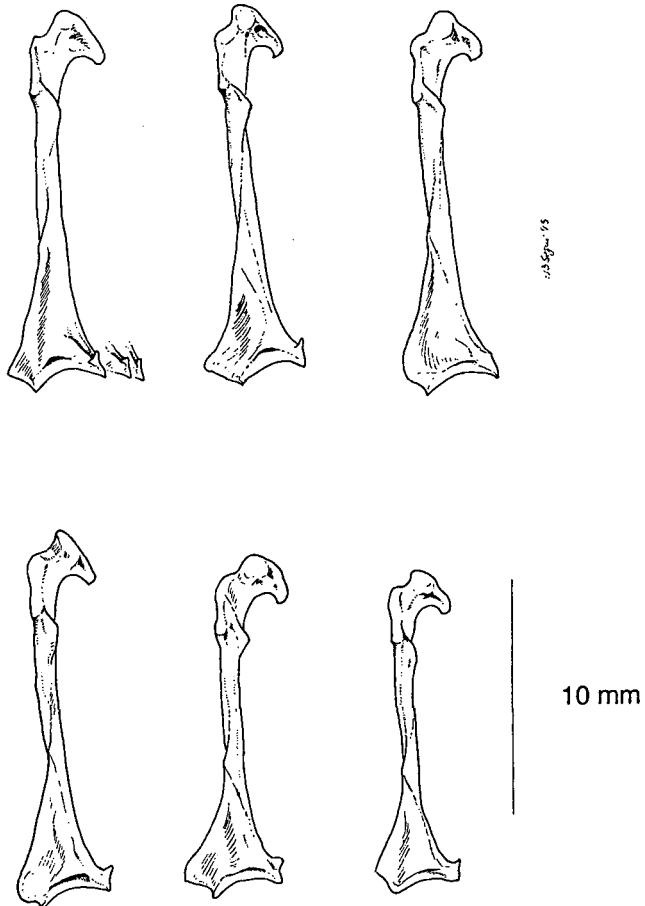


Fig. 3. Coracoids of (from left to right and downwards) *Muscicapa striata* (MNCM 21730), *Phoenicurus ochrurus* (MNCM 12521), *Saxicola rubetra* (MNCM 21787), *Erithacus rubecula* (MNCM 20630), *Ficedula hypoleuca* (MNCM 21716) and *Saxicola torquata* (MNCM 12513). Left side, dorsal view. Fig. 3. Coracoids de (d'esquerra a dreta i de dalt a baix) *Muscicapa striata* (MNCM 21730), *Phoenicurus ochrurus* (MNCM 12521), *Saxicola rubetra* (MNCM 21787), *Erithacus rubecula* (MNCM 20630), *Ficedula hypoleuca* (MNCM 21716) and *Saxicola torquata* (MNCM 12513). Costat esquerre, visió dorsal.

*Phoenicurus* species were also excluded due to a ventral depression located between the *Facies articularis clavicularis* and the *Processus acrocoracoideus*. *E. rubecula* shows a reduced or absent depression, and the *Facies articularis clavicularis* is shorter and less rounded.

The proximal epiphysis is built in another way in *S. rubetra*, the spine on the *Angulus medialis* being reduced or absent, the *Processus lateralis* is less developed and bigger than in *E. rubecula*. The coracoid of *S. torquata*, as well as that of *F. hypoleuca* is difficult to distinguish from that of *E. rubecula*. The bone of *S. torquata* is smaller and rather slender. In *F. hypoleuca* it is also of smaller size, and the *Processus acrocoracoideus* and *Facies articularis clavicularis* are stouter than in *E. rubecula*. In spite of this, the biometric overlap and character variation make a correct attribution in some cases impossible. *Luscinia* species compared were also excluded because of their larger size and slender proportions, showing a rather different morphology.

Fossil *E. rubecula* was recorded in Mallorca in the Cova Nova (McMinn & Alcover, 1992) as well as in the Pleistocene of Corsica (Alcover *et al.*, 1992) and Eivissa (Sondaar, 1995). In the Pedrera de S'Ònix (Alcover *et al.*, 1981) and in the Pleistocene of Crete (Alcover *et al.*, 1992) close forms were found. Nowadays it is a very common winter visitor in the Balearic Islands.

cf. *Erithacus rubecula* /*Luscinia* sp.

MATERIAL: Z 200-300: MNM 47003, right tarsometatarsus. MNI= 1.

The morphology of the fossil tarsometatarsus proves that it belongs to a small Turdidae. All osteological features are similar to *Erithacus rubecula*,

*Luscinia megarhynchos* and *L. svecica*. The length of the bone (26,90 mm) may allow attribution to *Luscinia* in accordance to published data (Moreno, 1987), but several *Erithacus* specimens in MNM clearly overlap in tarsometatarsus length with *Luscinia*. The fossil bone was found in the Z 200-300 level, dated 14.650 years b.p. (SM 63; Waldren, 1980) probably a colder period in which species are suspected to be bigger than nowadays. For these reasons the bone is better attributed to cf. *Erithacus rubecula*/*Luscinia* sp.

#### Genus *Phoenicurus*

*Phoenicurus* sp. cf. *P. phoenicurus* /  
*ochruros*

MATERIAL: Z 200-300: MNM 47002, left coracoid. MIN= 1.

The presence of a depression in the coracoid, ventrally to the proximal epiphysis and the development and curvature of the *Facies articularis clavicularis*, as described above for the genus *Phoenicurus*, allows attribution to it. Osteologic or biometric differences between *P. phoenicurus* and *P. ochruros* were not found.

Fossil remains attributed to this genus were also found in Eivissa (Sondaar *et al.*, 1995)

#### *Phoenicurus ochruros* (Gmelin)

MATERIAL: O 100-150: MNM 2671, proximal fragment of right humerus. MNI= 1.

The bone, despite of being fragmented, shares all features with living species, belonging to the morphology described by Jánossy (1983) for small Turdidae. The main features are the two well developed *Fossa pneumoanconae* and *tricipitalis*, clearly separated by the *Crus dorsale fossae*. *Oenanthe deserti*,

whose humeral length overlaps with *Phoenicurus ochruros* (Wessie, 1988) may be excluded for geographical reasons.

The cited material is the first record of the species for the gymnesic Pleistocene. It has neither been found on other of the Mediterranean islands. Nowadays *P. ochruros* is common in winter and during migration on the Balearic Islands.

#### Genus *Saxicola*

##### *Saxicola rubetra* (Linnaeus)

MATERIAL: Z 200-300: MNM 2690, right coracoid. MNI= 1.

The fossil coracoid belongs to the general pattern already described for *Erithacus rubecula*, also shared by *Phoenicurus phoenicurus*, *P. ochruros*, *Saxicola rubetra*, *S. torquata*, *Muscicapa striata* and *Ficedula hypoleuca*. Comparison with all of them allows exclusion of *E. rubecula* for reasons already discussed. Differences with *S. torquata* and *F. hypoleuca* were stated in reference to size, being the homologous bone of both of them clearly smaller and slightly-built. *M. striata*, both *Phoenicurus* species and *S. rubetra* overlap in length with the exhumed coracoid, but the osteology proves identity with the latter species. *Phoenicurus* species are excluded due to the already described depression ventral to the proximal epiphysis, as well as to the long and curved *Facies articularis clavicularis*. All these features are lacking in *S. rubetra*. *Muscicapa striata* possesses a well developed

*Angulus medialis*, already described in this work, while in *S. rubetra* the homologous structure is reduced or absent. The *Processus lateralis* is less developed in *S. rubetra* than in any of the species described.

*S. rubetra* had never been found in the Gymnesic Islands, but it has for the Pleistocene of Corsica (Alcover et al., 1992). Nowadays it is a common migrant, with some breeding attempts in Mallorca.

##### *Saxicola torquata* (Linnaeus)

MATERIAL: Z 200-300: MNM 2723, left tarsometatarsus. MNI= 1.

Some differences were stated between the tarsometatarsus of *Phoenicurus* and *Saxicola*. The *Foramen vasculare distale* is more distally located in the latter (Fig. 4) and the distal epiphysis is wider. A difference was made between *S. rubetra* and *S. torquata* thanks to the *Fossa metatarsi I*,

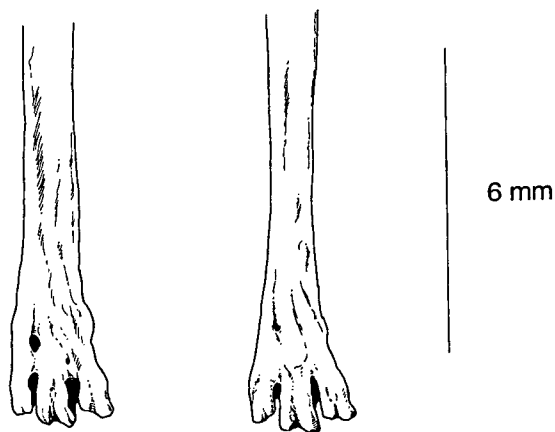


Fig. 4. Tarsometatarsus of *Saxicola torquata* (MNCM 20720, left) and *Phoenicurus phoenicurus* (MNCM 12540, right). Right side, dorsal view.

Fig. 4. Tarsometatars de *Saxicola torquata* (MNCM 20720, esquerra) i *Phoenicurus phoenicurus* (MNCM 12540, dreta). Costat dret, visió dorsal.

which possesses a more developed tuberculum in the latter species. A second tuberculum, located on the *Fossa ligamentus collateralis*, is again more conspicuous in *S. torquata*, the profile of the whole structure being more sinuous. Fossil biometrics (TL= 23,00 mm) reinforces attribution to *S. torquata* (Moreno, 1987).

Up to the present the species was unknown in the fossil record of Mediterranean islands. *S. torquata* is nowadays sedentary in Mallorca.

cf. *Saxicola rubetra/Phoenicurus phoenicurus*

MATERIAL: X 200-300: MNM 2721, right humerus. MNI=1.

Humerus of *Saxicola* shares, as well as that of *Phoenicurus* morphological similarities with *Muscicapa*, *Ficedula* and *Oenanthe*, the features being described by Jánossy (1983). Exclusion of *M. striata* and *F. hypoleuca* as well as of *P. ochruros* is due to differences already described in this work. *S. torquata* is of slender proportions, with less developed *Crista bicipitalis* and less stout proximal epiphysis. Coincidence is with *P. phoenicurus* and *S. rubetra*. Biometric overlap (Weesie, 1988; Moreno, 1987) does not allow exclusion of any of them.

Genus *Oenanthe*  
*Oenanthe oenanthe* (Linnaeus)

MATERIAL: O 100-150: MNM 47001, right humerus. MNI= 1.

The humeral osteology of *Oenanthe* is identical to that described for smaller Turdidae. Biometry allows clear intra-generic discrimination (Weesie, 1987; Moreno, 1987), the material (TL= 19,15 mm) being attributed to *Oenanthe oenanthe*.

The cited material is the first record of the species for any Mediterranean island. Nowadays *O. oenanthe* is a rather rare migrant and summer visitor on the Balearic Islands.

#### Genus *Turdus*

Palaearctic species of the genus *Turdus* share a homogeneous osteology and their biometrics strongly overlap (Stork, 1967; Moreno, 1987; Weesie, 1988). The generic determination of fossil humeri was done through comparison with recent material of *Sturnus vulgaris*, *S. unicolor*, *Monticola solitarius*, *M. saxatilis*, *Oenanthe oenanthe*, *O. hispanica*, *O. leucura* as well as with six western Palaearctic *Turdus* species: *T. iliacus*, *T. philomelos*, *T. merula*, *T. torquatus*, *T. pilaris* and *T. viscivorus*.

The genus *Oenanthe*, despite sharing with *Turdus* a humeral morphology in which both *Fossa tricipitalis* and *pneumoanconaea* are well developed and completely separated by the medial bar (Jánossy, 1983), is discarded due to its smaller size (Moreno, 1987). In *Monticola* species, contrary to *Turdus*, the medial bar possesses a ridge that extends ventrally into the *Fossa pneumoanconaea*. Differences with *Sturnus*, of similar biometrics (Moreno, 1987), are located also in the medial bar. From a caudoventral view, this structure is seen as a flat wall in *Turdus*, while in *Sturnus* there is some degree of inclination, giving *Fossa tricipitalis* a different shape. At the same time there is an imprint ventrally under the *Caput humeri* which extends longitudinally through the *Margo caudalis* at least until the middle point of the *Fossa pneumoanconaea* in *Sturnus*. In *Turdus* it never extends further from the described point.

Fossil tarsometatarsi where distinguished from those of *Monticola* thanks

to the slenderness of the bone in this genus. *Sturnus*, on the other hand, possesses shorter and stouter tarso-metatarsi. Plantar crests are more developed and the *Fossa infracotilaris dorsalis* is deeper and wider, provoking a lateral tuberculum in the medioventral side of the bone, beside of the fossa. Within, the bony bridge near *Foramina vascularia proximalia* is generally shorter (resembling a half ring) in *Sturnus*, while in *Turdus* it is longer (resembling a half cylinder). Nevertheless, juveniles of *Turdus* often have a poorly ossified bridge. At the distal end of the tarsometatarsus, *Trochlea metatarsi III* is more developed in *Sturnus*, rising dorsally over the plane defined by *Trochlea II* and *IV*. *Trochlea metatarsi II* possesses in *Sturnus* a small lateral tuberculum beside *Fovea ligamentus collateralis*, giving to the bone a more sinuous profile than in *Turdus*.

Coracoids of *Oenanthe* and *Monticola* are smaller and more slender than in *Turdus*, while in *Sturnus* there is again coincidence of size and stoutness with *Turdus* species. Nevertheless, there are some osteologic differences which allow discrimination of both genera. The edge of the *Processus lateralis* is sinuous in *Sturnus*, provoking a sharp tip in its cranial end, where the process joins two small crests. The profile of the structure is less sinuous in *Turdus*, the tip being rather undeveloped.

No differences were found in the proximal end of the bone, some proximal fragments remaining undetermined.

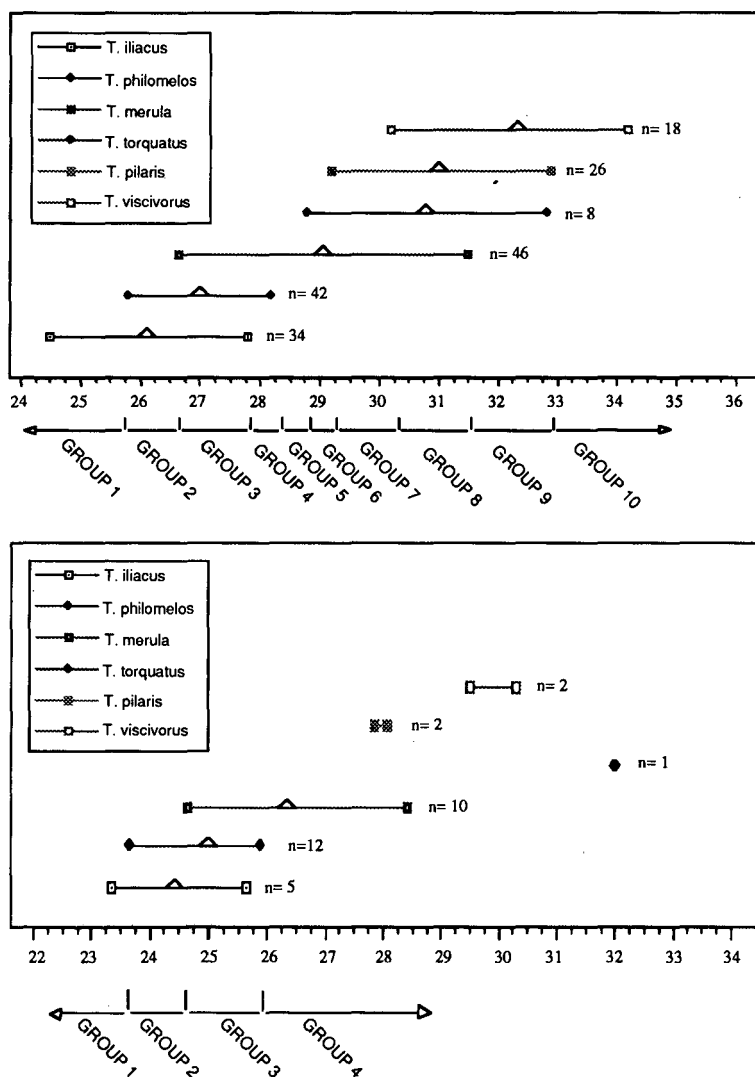
Intragenetic discrimination based on osteological features is very difficult (Wessie, 1988; Moreno, 1987), none of the differences stated by Jánossy (1983) being reliable in our reference material. The criteria used for the humerus by Weesie (1988) were adopted for the postcranial elements studied. Size

groups were formed for the humerus and the coracoid, from published data as well as from the authors' reference material (MNCHM). Tarsometatarsus were not considered because no complete remains were found.

Humeral total length data both from the authors and from Weesie (1988) were considered, belonging to *Turdus iliacus*, *Turdus philomelos*, *Turdus merula*, *Turdus torquatus*, *Turdus pilaris* and *Turdus viscivorus*. Assuming a normal distribution of the values of every species, the 90% confidence interval of the elements was calculated. In this way, overlap among species was reduced, despite assuming a 10% error. Size groups are defined as in Fig. 5.

In the case of the coracoid, both Total length and Partial length were studied, the last measurement being better preserved in the fossil remains. Correlation between both parameters is high ( $r = 0.964$ , std. error = 0.468,  $n = 32$ ) for the six species considered together, Partial length being an indirect estimation of Total length. Despite the sample being small, size groups are defined as in Fig. 5.

Fossil material attributed to *Turdus* was measured and referred to one of the size groups. Two main weak points of this methodology should be kept in mind: on one hand samples are not always representative, especially if they are small. On the other hand, it is proved that species size has varied since the Upper Pleistocene (Florit & Alcover, 1987b). Some remains belong to Z 750 level, dated 32,000 years b.p. (SM 74; Waldren, 1980), though most of them come from Z 200-300 level and X 200-300, dated 14,650 years b.p. (SM 63; Waldren, 1980). This chronology refers the fossil materials to a postwürmian age, hotter than the period described by Florit & Alcover (1987b)



**Fig. 5.** A) Intervals grouping 90% of TL of the humerus (mm) for *Turdus* species and formation of size groups. Data from the authors (specimens from MNCM) combined with data published by Weesie (1988). B) Intervals of TL of the coracoid and formation of size groups in the same species. The same methodology has been applied to PLC of the coracoid. Data from the authors (MNCM collection). The triangle over the bar indicates the mean of the sample.

*Fig. 5.* A) Intervals que inclouen el 90% de la TL (longitud total) de l'húmer (mm) per a les espècies del gènere *Turdus* i formació de les classes de talla. B) Intervals de TL del coracoid i formació de les classes de talla en les mateixes espècies. El mateix mètode s'ha aplicat a la PLC (longitud parcial) del coracoid. Dades dels autors (col.lecció MNCM). El triangle sobre la barra indica la mitjana de la mostra.



but cooler than the present one, as proved by the finding of species that nowadays are distributed further north as well as by the stoutness of others compared with conspecific modern forms. Modern samples are, thus, not entirely representative of the species variation achieved in the past.

## HUMERUS

*GROUP 1: Turdus iliacus.*  
TL < 25.80 mm

MATERIAL: X 200-300: MNMCM 2619, right humerus. MNI = 1.

*GROUP 2: Turdus sp. cf. T. iliacus/philomelos*  
25.80 < TL < 26.65 mm

MATERIAL: X 200-300: MNMCM 2604, left humerus. MNI = 1.

*GROUP 3: Turdus sp. cf. T. iliacus/philomelos/merula*  
26.65 < TL < 27.80 mm

MATERIAL: X 200: MNMCM 2750, right humerus; MNMCM 2966, MNMCM 2752, left humerus. MNI = 2.

*GROUP 4: Turdus sp. cf. T. philomelos/merula*  
27.80 < TL < 28.20 mm

MATERIAL: Z 700: MNMCM 2751, right humerus; X 200-300: MNMCM 2601, left humerus. MNI = 1.

*GROUP 5: Turdus merula*  
28.20 < TL < 28.80 mm

MATERIAL: AB: MNMCM 2965, right humerus. MNI = 1.

*GROUP 6: Turdus sp. cf. T. merula/torquatos*  
28.80 < TL < 29.20 mm

MATERIAL: X 200-300: MNMCM 2793, right humerus; X 200: MNMCM 2792, right humerus. MNI = 2.

*GROUP 7: Turdus sp. cf. T. merula/torquatos/pilaris*  
29.20 < TL < 30.20 mm

MATERIAL: Z 200-300: MNMCM 2974, left humerus. MNI = 1.

*GROUP 8: Turdus sp. cf. T. merula/torquatos/pilaris/viscivorus*  
30.20 < TL < 31.50 mm

MATERIAL: X 200-300: MNMCM 2770, left humerus; Z 200-300: MNMCM 2835, MNMCM 2837, left humeri; MNMCM 2836, right humerus. MNI = 3.

*GROUP 9: Turdus sp. cf. T. torquatos/pilaris/viscivorus*  
31.50 < TL < 32.90 mm

MATERIAL: Z 200-300: MNMCM 2834, MNMCM 2833, right humeri; MNMCM 2832, left humeri; Z 750: MNMCM 2821, left humerus. MNI = 2.

## CORACOID

*GROUP 2: Turdus sp. cf. T. iliacus/philomelos*  
23.65 < TL < 24.65 mm  
22.70 < PL < 23.65 mm

MATERIAL: O 100-150: MNMCM 2775, MNMCM 2612, left coracoids. MNI = 2.

*GROUP 3: Turdus sp. cf. T. iliacus/philomelos/merula*  
24.65 < TL < 25.90 mm  
23.65 < PL < 25.55 mm

MATERIAL: Z 200-300, MNCM 2804, MNCM 2805, right coracoid; MNCM 2808, MNCM 2775, MNCM 2779, MNCM 2976, MNCM 2613, left coracoid. MNI= 5.

GROUP 4: *Turdus* sp. cf. *T. merula/torquatos/pilaris/viscivorus*

TL>25.90 mm

PL>25.55 mm

MATERIAL: Z 200-300: MNCM 2876, MNCM 2873, MNCM 2874, MNCM 2881, MNCM 2875, MNCM 2880, right coracoids; MNCM 2877, MNCM 2879, MNCM 2878, MNCM 2872, left coracoids; Z 750: MNCM 2823, right coracoids; O 100-150, MNCM 2824, MNCM 2830, left coracoids. MNI= 7.

*Turdus* sp.

MATERIAL: AB: MNCM 47014, MNCM 47015, distal fragment of rostrum; MNCM 47019, proximal fragment of left mandible; CD 100-150: MNCM 2929, proximal fragment of left humerus; O 100-150: MNCM 2787, proximal fragment of right coracoid; MNCM 2753, proximal fragment of left humerus; MNCM 2791, distal fragment of right tarsometatarsus; MNCM 2759, MNCM 2767, MNCM 2768, proximal fragments of right tarsometatarsi; X 200-300: MNCM 2771, proximal fragment left coracoid; MNCM 2776, distal fragment of left coracoid; MNCM 2605, medial fragment of right humerus; MNCM 2602, MNCM 2603, fragmented right humeri; MNCM 2606, fragmented left humerus; Z 200-300: MNCM 2883, proximal fragment of coracoid; MNCM 2891, distal fragment of right coracoid; MNCM 2807, MNCM 2885, MNCM 2886, MNCM 2888, proximal fragments of right coracoids; MNCM 2882, distal fragment of left coracoid; MNCM 2806, MNCM 2810, MNCM 2884,

MNCM 2889, MNCM 2890, MNCM 2892, MNCM 2893, proximal fragments of left coracoids; MNCM 2809, fragmented left coracoid; MNCM 28, proximal fragment of right humerus; MNCM 2839, MNCM 2840, proximal fragment of right humerus; MNCM 2841, distal fragment of left humerus; MNCM 2843, MNCM 2795, MNCM 2842, proximal fragments of left humeri; MNCM 2819, proximal fragment of tarsometatarsi; MNCM 2912, MNCM 2993, distal fragments of right tarsometatarsi; MNCM 2817, MNCM 2907, MNCM 2909, proximal fragments of right tarsometatarsi; MNCM 2820, MNCM 2911, MNCM 2913, MNCM 2914, MNCM 2915, distal fragments of left tarsometatarsi; MNCM 2818, MNCM 2908, proximal fragments of left tarsometatarsi; MNCM 2916, distal fragment of right tarsometatarsi.

Some fragments of humerus, coracoid and tarsometatarsus, impossible to be measured, were only generically determined. There is also in this category a distal fragment of rostrum, attributed to *Turdus* after comparison with several species of *Oenanthe*, *Oriolus oriolus*, *Sturnus vulgaris*, *Sturnus unicolor*, *Monticola solitarius* and *Monticola saxatilis*. *Oenanthe* species were excluded due to their smaller size, against *Oriolus*, whose rostrum is stouter, wider and with a less developed palatal concavity than in *Turdus*. Both *Monticola* species were excluded because of their flat palate, as well as for their elongated, slender beak. Both features are also shared with *Sturnus*, having a longer bill, wider in this case than *Turdus* and with a less developed palatal concavity.

A proximal fragment of the left mandible was also attributed to *Turdus*; *Sturnus* and *Oriolus* being discarded due to their slender proportions, more developed *Fenestra mandibulae* and differ-

ent curvature of the *Angulus mandibulae*. The *Processus retroarticularis* in *Monticola* is of different shape, the *Processus mandibulae medialis* is less protruded and the *Fenestra mandibulae* less developed.

Finally, a mandibular symphysis was also referred to *Turdus*, due to its shorter symphysal length in reference to *Sturnus* and *Oriolus*. Comparison with *Monticola* allows exclusion from this genus, the mandible being narrower in reference to the length of the *Pars symphysalis*. Concavity of the bone is greater in the fossil and the proximo-medial side of both mandibular rami, beside the *Pars symphysalis*, is different than that in *Monticola* but similar to *Turdus*.

Remains of *Turdus* species were recorded from many quaternary fossil sites from the Gymnesic and Pityusic islands as well from all Mediterranean islands with known fossil record (Alcover et al., 1992). Nowadays, *Turdus merula* is sedentary in the Balearic islands, while *T. iliacus*, *T. philomelos*, *T. torquatos*, *T. pilaris* and *T. viscivorus* are winter visitors and migrant in the archipelago.

#### Family SYLVIIDAE

##### Genus *Sylvia*

##### *Sylvia* cf. *sarda* Temminck

MATERIAL: AB: MNM 2957, left tarsometatarsus. MNI= 1.

The distal epiphysis of the tarso-metatarsus of *Phylloscopus* differs from those of *Sylvia*, in the morphology of the *Incisura intertrochlearis medialis*. Within the genus *Sylvia*, discrimination is more subtle. The fossil bone belongs to a size class including smaller species. Morphology is very similar to *S. sarda*, *S. curruca* being stouter, with a wide distal epiphysis. *Fossa metatarsi I* is very con-

cave in *Sylvia cantillans* giving a prominent aspect to the *Trochlea metatarsi II*.

These features are shared by *S. undata*, despite only two individuals being examined. In *S. sarda*, *Fossa metatarsi I* shows a sinuous profile, and the shape of the *Trochlea metatarsi II* is different. Comparison with *S. conspicillata* was not possible, so the material is tentatively referred to *Sylvia* cf. *sarda*.

The genus has already been recorded in the Gymnesic Islands (Ballman & Adrover, 1970) as well as in other Mediterranean islands (Alcover et al., 1992). Nowadays *S. sarda* is sedentary in the Balearic archipelago, though Menorcan populations seem to be non-breeding (Gargallo, 1991).

##### *Sylvia* cf. *Sylvia melanocephala/curruca*

MATERIAL: O 100-150: MNM 2724, right humerus. MNI= 1.

Some humeral differences between *Phylloscopus* and *Sylvia* are stated by Jánossy (1983). Our observations prove that *Fossa tricipitalis* is less developed in *Sylvia*, but the longitudinal fold described by Jánossy is ill-defined in some individuals. *Crista pectoralis* is shorter and narrower as stated by the author, giving to the proximal epiphysis a less globose aspect than in *Phylloscopus*.

The size of the bone refers it to a middle-sized species (i.e. *S. melanocephala*, *S. curruca*). No comparison with *S. conspicillata* was possible, and humeral measurements were not found in the bibliography. We think the species can be excluded on their general external biometry (Cramp & Simmons, 1992), which refers the species to the small-sized *Sylvia* group. Despite osteological and biometric similarities with the two formerly mentioned species, specific attribution was not attempted because the comparison series of *S. curruca* is rather small.

*Sylvia* sp.

MATERIAL: Z 200-300: MNM 2679, proximal fragment of right humerus. MNI= 1.

The material belongs to the small-sized *Sylvia* group (vgr. *S. undata*, *S. sarda*, *S. cantillans* and possibly *S. conspicillata*, the latter not compared). The poor preservation of the fossil only allows a generic determination.

Genus *Phylloscopus*  
*Phylloscopus* sp.

MATERIAL: O 100-150: MNM 2677, proximal fragment of right humerus. MNI= 1.

Humeral features of *Phylloscopus* and discrimination from *Sylvia* have already been treated in the text. An intrageneric determination was impossible due to biometric overlap (Moreno, 1987) and to the fragmentary condition of the fossil material.

The cited material is the first record from the Gymnesic Islands as well as from the other paleornithologically known Mediterranean islands. Nowadays only *P. collybita* and *P. trochillus* are common in the Balearic Islands in winter and during migration.

Family MUSCICAPIDAE  
Genus *Ficedula*  
*Ficedula hypoleuca* (Pallas)

MATERIAL: X 200-300: MNM 2731, fragmented right humerus; MNM 2732, proximal fragment of right humerus. MNI= 2.

The similarities of the humerus of the Muscicapidae are with small Turdidae. The genera *Phoenicurus* and *Saxicola* were discarded due to their longer and narrower proximal epiphysis, less developed *Crista pectoralis* with

sinuous profile, and in general, for their slenderness (Moreno, 1987). All these features are coincident with *Erithacus* and *Luscinia*, which in addition possess an undeveloped *Fossa tricipitalis* (Jánossy, 1983) -although this feature has some degree of variation-. The osteology of *Muscicapa striata* is similar to *F. hypoleuca*, but biometrics prove the latter being smaller (Moreno, 1987).

The cited material is the first record of the species for the Gymnesic Islands (Alcover *et al.*, 1992). Nowadays *Ficedula hypoleuca* is a common migrant in the Balearics.

Family PARIDAE  
Genus *Parus*  
*Parus ater* Linnaeus

MATERIAL: Z 200-300: MNM 2578, left humerus. MNI= 1.

The humerus of *Paridae* is very well defined due to the pneumatization of the *Fossa tricipitalis* (Jánossy, 1983). Within the family, the size is coincident with *P. ater*. The only individual compared is osteologically identical and the Total length of the bone (12,35 mm) is in agreement with published data (Moreno, 1987).

A close form of *Parus ater* was found in the Pedrera de S'Ònix (Alcover *et al.*, 1981). No *Paridae* have been recorded from any other Mediterranean island (Alcover *et al.*, 1992). The species is nowadays uncommon in the Balearic Islands.

Family LANIDAE  
Genus *Lanius*  
*Lanius* cf. *L. excubitor* L./minor Gmelin

MATERIAL: Z 200-300: MNM 2621, proximal fragment of right humerus; O 200: MNM 47166, braincase; O 100-150, MNM 2620, left humerus. MNI= 1.

Jánossy (1983) describes the humeral morphology of *Lanius* characterized by a shallow *Fossa tricipitalis*, tending to be pneumatized and without a longitudinal fold. The well developed *Crista pectoralis* possesses an impression in the *Margo caudalis*. All these features are shared by the fossil material. Intrageneric comparison was made with *Lanius senator*, *L. collurio* and *L. excubitor*. *L. minor* was not available, but Jánossy's published biometric data of this species (1983), fully agree with the fossil humerus (Total length= 25,15 mm, MNCM 2620). The author proposed an intrageneric attribution of the species based on size. Nevertheless, in our reference material *L. excubitor* overlaps with Jánossy's data of *L. minor*. The material is consequently attributed to *Lanius cf. excubitor/minor*.

Both *L. excubitor* and *L. minor* were recorded in Cova Nova (Florit & Alcover, 1987a), but this attribution should be revised due to the biometric overlap stated. Recoveries were also achieved in the Pleistocene of Eivissa and Corsica (Alcover et al., 1992; Sondaar et al., 1995). Nowadays their presence in the Balearic Islands is very rare.

Family CORVIDAE  
Genus *Pyrrhonorax*

After comparison with Western Palearctic Corvidae, the material was attributed to *Pyrrhonorax*. Intrageneric assignment of postcranial elements is difficult. Biometry seems to be a basic tool (Weesie, 1988; Moreno, 1986; Mourer-Chauviré, 1975). Specific attribution was done attending to published biometry from both Würmian and present-day populations (Florit & Alcover, 1987; Mourer-Chauviré, 1975).

*Pyrrhonorax graculus* (Linnaeus)

MATERIAL: Z 200-300: MNCM 2713, left coracoid; MNCM 2708, distal fragment of left humerus; MNCM 2707, right humerus; MNCM 2711, right carpometacarpus; MNCM 2716, fragmented left tarsometatarsus; X 200: MNCM 2706, right tarsometatarsus; MNCM 2715, fragmented right tarsometatarsus; MNCM 2710, distal fragment of left ulna; MNCM 2709, proximal fragment of left ulna; AB: MNCM 47018, distal fragment of rostrum; MNCM 2953, distal fragment of right tarsometatarsus; MNCM 2954, distal fragment of left tarsometatarsus; Z 750, MNCM 2701, distal fragment of left femur; MNCM 2717, fragmented carpometacarpus; O 100-150: MNCM 2718, proximal fragment of right carpometacarpus; MNCM 2720, distal fragment of left tibiotarsus. MNI= 3.

The distal fragment of rostrum was discriminated from that in *P. pyrrhonorax* due to its shortness and curvature. The species is a common faunistic pleistocene element in the Mediterranean (Alcover et al., 1992). In Mallorca it was found in Avenc de na Corna, Cova Nova, Cova de Llenaire and Cova des Moro (Bate, 1928; Lambrecht, 1933; Mourer-Chauviré et al., 1977; Alcover et al., 1981; Florit & Alcover, 1987a). Nowadays the species is very uncommon in the Balearic Islands.

*Pyrrhonorax pyrrhonorax* (Linnaeus)

MATERIAL: Z 750: MNCM 2699, proximal fragment of femur; MNCM 2698, fragmented left femur; MNCM 2703, proximal fragment of left tarsometatarsus; MNCM 2702, distal fragment of right tarsometatarsus; MNCM 2695, right ulna; MNCM 2696, distal fragment of left ulna; MNCM 2700, fragmented left ulna; MNCM 2712, proximal fragment of right

ulna; CD 100-150: MNM 2925, fragmented left tibiotarsus. MNI= 2.

*P. pyrrhonorax* was found in the Cova Nova and Cova de Llenaire (Mallorca; Mourer-Chauviré *et al.*, 1977; Florit & Alcover, 1987a) as well as in Cala En Blanes 1974 (Menorca; Reumer, 1982). As for *P. graculus*, *P. pyrrhonorax* is a common element in the insular Mediterranean fossil record (Alcover *et al.*, 1992). Nowadays *P. pyrrhonorax* is vagrant in the Balearic Islands.

*Pyrrhonorax* sp.

MATERIAL: Z 200-300: MNM 2714, proximal fragment of left coracoid; CD 100-150: MNM 2924, proximal fragment of right scapula; MNM 2923, proximal fragment of radius; O 100-150: MNM 2705, distal fragment of right femur; MNM 2719, distal fragment of right carpometacarpus; MNM 2704, distal fragment of left carpometacarpus; AB: MNM 2952, proximal fragment of left carpometacarpus.

Some fragmented material is determined only to generic level.

Family STURNIDAE

Genus *Sturnus*

*Sturnus* sp.

MATERIAL: O 100-150: MNM 2766, right tarsometatarsus. MNI= 1.

Distinction between the tarsometatarsi of *Turdus* and *Sturnus* has already been stated in this paper. *Monticola* species possess a slender tarsometatarsus, with undeveloped plantar crests, quite different from the fossil material. Intrageneric assignment of the remains was not possible because osteologic differences between *Sturnus* species studied were not found. Biometric segregation was neither possible (Moreno, 1987).

The cited material is the first record of the genus in the Gymnesic Islands, although it is already known from other Mediterranean islands (Alcover *et al.*, 1992).

Family PASSERIDAE

Genus *Passer*

*Passer* sp. cf. *P. domesticus*  
*hispaniolensis*

MATERIAL: X 200-300: MNM 47010, left tarsometatarsus. MNI= 1.

Carduelidae of similar size possess a more slender tarsometatarsus than *Passer*. Nevertheless, the fossil greatly resembles *Carduelis chloris*, but the diaphysis is longer in *this species* in reference to the width of the epiphysis. Emberizidae were excluded due to the particular development of *Trochlea metatarsi II*, which looks rotated, stout and flattened.

Within the Passeridae comparison was made with *Montifringilla nivalis*, *Petronia petronia*, *Passer hispaniolensis*, *P. domesticus* and *P. montanus*. *M. nivalis* was excluded for its bigger size. In *Petronia petronia*, tarsometatarsus is stouter and shorter. *Passer montanus* is smaller. There is a clear coincidence with *Passer domesticus* and *P. hispaniolensis*. It is impossible to find reliable osteologic characters or biometric segregation between them.

The genus has never been recorded for a Mediterranean island with known fossil record. Alcover *et al.* (1992), state that both *P. domesticus* and *P. hispaniolensis*, which today inhabit some islands, have colonized them in the Holocene. This argument is against chronostratigraphic data, referring materials from Z 200-300 to 12,000-15,000 years b.p. (Waldren, 1982). Anthropogenic mammals (*Mus*, *Apodemus*...) are also present in this level, thus datation probably is not accurate.

Nowadays only *P. domesticus* is present on the Balearic Islands, being a common sedentary species.

#### Genus *Petronia*

*Petronia petronia* (Linnaeus)

MATERIAL: X 200-300: MNCM 47013, distal fragment of rostrum; MNCM 47012, fragmented mandible. MNI= 1.

The unearthed cranial fragments probably belong to a single individual. The fossil form is slightly stouter than the modern skeletons of the species compared.

*P. petronia* has never been recorded from a gymnesic fossil site, but it has been for Corsica (Alcover et al., 1992). Nowadays the status of the species in the island is not clear, but there seems to be a sedentary population.

#### Genus *Montifringilla*

*Montifringilla nivalis* (Linnaeus)

MATERIAL: AB: MNCM 47017, left coracoid; E150-250: MNCM 47004, proximal fragment of left coracoid; O 100-150: MNCM 47008, distal mandibular fragment. MNI= 2.

Fossil coracoids were compared with homologous elements of bigger Carduelidae, Fringillidae, Emberizidae and Passeridae. *Coccothraustes*, *Pinicola* and *Loxia* species were discarded due to their larger size and robustness, as well as to the less prominent *Facies articularis clavicularis*. *Miliaria calandra* is stouter and its *Facies articularis clavicularis* is more slender. Among the Passeridae, *Passer domesticus*, *P. hispaniolensis* and *Plectrophenax nivalis* are smaller and their *Facies articularis clavicularis* are less developed and less curved than in *M. nivalis*. *P. petronia* is stouter despite the bone being shorter. *Sulcus musculus supracoracoidei* is extremely wide in this species.

The fossil mandibular symphysis resembles those of bigger Western Palearctic Passeridae. Osteological characters are difficult to study in this poorly preserved material, but the relation between symphyseal length and maximum width of the fragment clearly resembles *M. nivalis*, which possesses a long and slender bill. Size is coincident also with *P. petronia*, but the fossil rostrum and mandible assigned to this taxon (see above) are stouter than our fossil material as well as our reference one. This does not happen with the fossil coracoids attributed to *M. nivalis*, because they are coincident in size with modern species.

*Montifringilla nivalis* was also recorded from the Cova Nova (McMinn & Alcover, 1992). The species is also known in Eivissa (Sondaar et al., 1995). Nowadays it is a rather rare winter visitor in the Balearic Islands.

#### Family FRINGILLIDAE

##### Genus *Fringilla*

*Fringilla* sp. cf. *F. coelebs/montifringilla*

MATERIAL: E 100-150: MNCM 2614, left humerus; AB: MNCM 2495, left humerus; X 200-300; MNCM 47070, fragmented right humerus; MNCM 47069, right humerus. MNI= 2.

The presence of a small fossa in the *Crus ventrale* allows identification of the humeri of the genus *Fringilla* (McMinn & Alcover, 1992), among those of similar sized Carduelidae, Emberizidae and Motacillidae. Nevertheless, intra-generic determination was not possible. Differences between *F. coelebs* and *F. montifringilla* stated by Jánossy (1983) are not clearly seen in our reference material.

*F. coelebs* is known from Pedrera de s'Ònix and Cova de Llenaire (Mourer-Chauviré et al., 1977). Close

forms were also found in Pedrera de s'Ònix (Alcover *et al.*, 1981) and Cova Nova (McMinn & Alcover, 1992). The taxon was also recorded for Eivissa (Sondaar *et al.*, 1995), Corsica (Alcover *et al.*, 1992), Tavolara (Lydekker, 1891) and Crete (Weesie, 1988).

Nowadays *F. coelebs* is sedentary in Mallorca and a winter visitor in Menorca. *F. montifringilla* is a rather rare migrant and winter visitor in the archipelago.

#### Genus *Carduelis*

##### *Carduelis chloris* (Linnaeus)

MATERIAL: X 200-300: MNM 47068, right humerus; MNM 47071, left tarsometatarsus; Z 200-300: MNM 2635, right humerus; MNM 2650, right tarsometatarsus. MNI= 2.

Among the medium-sized Emberizidae, Carduelidae and Motacillidae, *C. chloris* is unique in its proportions due to the stoutness of the epiphysis with regard to the length of the bone. Confusion with *Fringilla* is not possible if we consider the features already described in the humerus of this genus.

The main similarities of the tarsometatarsus of *C. chloris* are with *Fringilla* and *Passer*. Emberizidae were discarded due to the special morphology of *Trochlea metatarsi II* in this family. Passeridae tend to be stouter, with narrower proximal epiphysis and with trochleae built in another way. Some differences between *Passer* and *C. chloris* have already been discussed. Among Carduelidae and Fringillidae, the size is coincident with *Fringilla*. Proportions are, nevertheless, more slender in this genus, with the epiphysis less stout and with a thin diaphysis.

*C. chloris* has never been cited in the Gymnesic Islands, but it has in Eivissa (Sondaar *et al.*, 1995), Corsica

and Crete (Alcover *et al.*, 1992; Weesie, 1988) and Malta (Fischer & Stephan, 1974). Nowadays the species is sedentary in the Balearics, with the population increasing in winter and during migration.

##### *Carduelis* sp. cf. *C. carduelis/cannabina*

MATERIAL: E 100-150: MNM 2616, left humerus. MNI= 1.

The features of the bone indicate affiliation to a small Carduelidae, of the size of *C. carduelis* and *C. cannabina*. Nevertheless, it was not possible to recognize in our material the differences between these species stated by Jánossy (1983).

Both species have been recorded from several localities on the island (Ballman & Adrover, 1970; Alcover *et al.*, 1981; Alcover *et al.*, 1992). *C. cannabina* is also known from Eivissa (Sondaar *et al.*, 1995). Their status in the Balearics is sedentary with the population increasing in winter and during migration.

#### Genus *Loxia*

##### *Loxia curvirostra* Linnaeus

MATERIAL: O 100-150: MNM 2656, distal fragment of right tarsometatarsus. MNI= 1.

The fragmentary state of the material makes determination difficult, but osteological features show identity with a middle-sized heavy-billed passerine. Greater similarities are with *Coccothraustes coccothraustes* and with *L. curvirostra*, but *Foramen vasculare distale* is more distally placed in the former species, while *Trochlea metatarsi II* is stouter in the latter and possesses a more sharpened tuberculum beside the *Fovea ligamentus collateralis*.

This taxon was recorded for the Cova Nova (Florit & Alcover, 1987a). It



is unknown in the fossil record of the remaining Mediterranean islands (Alcover et al., 1992). Nowadays it is sedentary in Mallorca.

Genus *Coccothraustes*  
*Coccothraustes coccothraustes*  
(Linnaeus)

MATERIAL: Sector CD 100-150: MNM 2919, distal fragment of right humerus; E 150-250: MNM 47062, proximal fragment of left humerus; MNM 47063, right tarsometatarsus; AB: MNM 2958, right humerus; X 200-300, MNM 47058, mandible; MNM 47059, right humerus; MNM 47060, fragment of right humerus; MNM 47061, proximal fragment of left humerus; Z 200-300: MNM 47064, right humerus; MNM 47065, proximal fragment right humerus; MNM 47066, left humerus; MNM 47067, proximal fragment of left humerus; Z 700: MNM 2628, right humerus. MNI= 7.

The humerus of *C. coccothraustes* exhibits all the features of the bigger Carduelidae (Jánossy, 1983). Comparison was done with *Loxia curvirostra*, *L. leucoptera* and *Pinicola enucleator*. *Loxia* species were discarded due to the great width of the proximal epiphysis, causing the bone to be stouter. *Pinicola* is bigger and its humeral osteology is peculiar in the family (Jánossy, 1983).

*C. coccothraustes* was already known from the Pliocene and Pleistocene gymnesic fossil record (Ballman & Adrover, 1970; Alcover et al., 1981). It was also known in more recent sites from Eivissa (Sondaar et al., 1995) and in the insular Mediterranean: Corsica and Armathia (Alcover et al., 1992), Crete (Weesie, 1988), Tavolara (Lydekker, 1891) and Malta (Fischer Stephan, 1974).

Nowadays the species is a rather rare migrant and winter visitor in Mallorca.

Family EMBERIZIDAE  
*Emberiza* sp. cf. *E. cirulus/citrinella*

MATERIAL: Sector Z 200-300: MNM 47013, fragmented mandibular symphysis. MNI= 1.

The beak in the Emberizidae is characterized by the angle affecting both mandible and premaxilla (Moreno, 1985). The size of the fossil is similar to *E. schoeniclus*, *E. cia*, *E. cirulus* and *E. citrinella*. In the two latter species, *Angulus mandibulae* is laterally widened, as in the fossil, but not in *E. schoeniclus* and *E. cia*. No clear differences were found between *E. cirulus* and *E. citrinella*.

The genus has been recorded just once in the Gymnesic Islands (*E. cia/hortulana*), also from a mandible fragment from Cova Nova (McMinn & Alcover, 1992). Other non-specific determinations are known from other Mediterranean islands (Alcover et al., 1992).

Nowdays *E. cirulus* is sedentary in Mallorca, while *E. citrinella* is a rare migrant.

Undetermined materials

Some material remains undetermined, mainly due to its poorly preserved condition and lack of diagnostic features. Most of it belongs to the Order Passeriformes.

MATERIAL: 2 phalanges, 36 scapulae, 29 vertebrae, 2 radii, 3 furculae, 12 sternebrae, 44 tibiotarsi, 22 mandibles, 75 ulnae, 4 ischia, 16 ribs, 5 humeri, 52 carpometacarpi, 16 femora, 4 coracoids, 2 rostra, 93 unknown elements.

SPECIES	CD 100-150 O 100-150 E 100-150 6.000-9.000 Y. b.p.	E 150-250 X 200 9.000-15.000 Y. b.p.	Z 200-300 X 200-300 +/- 15.000 Y. b.p.	Z 750 Z 700 +/- 30.000 Y. b.p.	AB unknown
<i>Branta cf. bernicla</i>	+				
<i>Tadorna sp.</i>			+		
<i>Alectoris cf. rufa</i>	+				
<i>Coturnix coturnix</i>	+				
<i>Porzana porzana</i>			+		+
<i>Columba sp. cf. C. livia/oenas</i>			+		
<i>Tyto alba</i>	+		+		
<i>Otus scops</i>		+			
<i>Athene noctua</i>			+		
<i>Apus sp. cf. A. apus/pallidus</i>			+		
<i>Jynx torquilla</i>	+				
<i>Calandrella sp.</i>					+
<i>Alauda arvensis</i>			+		
<i>Alaudidae sp.</i>		+			
<i>Anthus pratensis</i>	+				
<i>Motacillidae sp.</i>	+		+		
<i>cf. Hirundo sp./Ptyonoprogne rupestris</i>			+		
<i>Prunella modularis</i>					+
<i>Erithacus rubecula</i>	+	+	+		+
<i>cf. Erithacus rubecula/Luscinia sp.</i>			+		
<i>Phoenicurus sp. cf. P. phoenicurus/ochuros</i>			+		
<i>Phoenicurus ochruros</i>	+				
<i>Saxicola rubetra</i>			+		
<i>Saxicola torquata</i>			+		
<i>cf. Saxicola rubetra/Phoenicurus phoenicurus</i>			+		
<i>Oenanthe oenanthe</i>	+				
<i>Turdus iliacus</i>			+		
<i>Turdus merula</i>					+
<i>Turdus sp.</i>	+	+	+	+	
<i>Sylvia cf. sarda</i>					+
<i>Sylvia sp. cf. S. melanocephala/curruca</i>	+				
<i>Sylvia sp.</i>			+		
<i>Phylloscopus sp.</i>	+				
<i>Ficedula hypoleuca</i>			+		
<i>Parus ater</i>			+		
<i>Lanius sp. cf. L. excubitor/minor</i>	+		+		
<i>Pyrrhocorax graculus</i>	+	+	+	+	+
<i>Pyrrhocorax pyrrhocorax</i>	+			+	
<i>Pyrrhocorax sp.</i>	+		+		+
<i>Sturnus sp.</i>	+				
<i>Passer sp. cf. P. domesticus/hispaniolensis</i>			+		
<i>Petronia petronia</i>			+		
<i>Montifringilla nivalis</i>	+	+			+
<i>Fringilla sp. cf. F. coelebs/montifringilla</i>	+		+		+
<i>Carduelis chloris</i>			+		
<i>Carduelis sp. cf. C. carduelis/cannabina</i>	+				
<i>Loxia curvirostra</i>	+				
<i>Coccothraustes coccothraustes</i>	+	+	+	+	+
<i>Emberiza sp. cf. E. cirius/citrinella</i>			+		

Table 1. Stratigraphic distribution of the fossil avifauna of Moleta Cave.

Taula 1. Distribució estratigràfica de l'avifauna fòssil de la Cova de Moleta.

## Discussion

Table 1 presents the stratigraphic distribution of the fossil ornithofauna from the Moleta Cave. A minimum of 41 and a maximum of 50 species have been determined. At least 14 are new to the Gymnesic Islands: *Branta* cf. *bernicla*, *Alectoris* cf. *rufa*, *Alauda arvensis*, *Anthus pratensis*, *Phoenicurus ochruros*, *Saxicola rubetra*, *S. torquata*, *Oenanthe oenanthe*, *Sylvia* cf. *sarda*, *Sylvia* sp. cf. *S. melanocephala/curruca*, *Ficedula hypoleuca*, *Passer* sp. cf. *domesticus/hispaniolensis*, *Petronia petronia* and *Carduelis chloris*. Four others belong to genera new for the fossil record of Gymnesic Islands: *Tadorna* sp., *Calandrella* sp., *Phylloscopus* sp. and *Sturnus* sp. Of the taxa mentioned, 13 are new for the Balearic Islands (cf. Sondaar et al., 1995). *Alectoris* cf. *rufa*, *Anthus pratensis*, *Phoenicurus ochruros*, *Saxicola torquata*, *Sylvia* cf. *sarda* and *Sylvia* sp. cf. *S. melanocephala/curruca* have never been cited as fossils from any other Mediterranean island.

Apart from the absolute abundance of taxa, another notable aspect of the Moleta Cave is the frequency of Passeriformes not belonging to the family Corvidae. This group is poorly represented in the fossil record due to the fragility of its skeletal elements (Weesie, 1988) and its small size. Other factors, such as the techniques used for gathering and processing materials, as well as the greatest interest shown by paleontologists in the study of non-passerines rather than the smaller and osteologically more complex passerines, may accentuate this bias. The small-sized passerines represent 73-78 % of the fossil ornithofauna of the Moleta Cave. In the avifauna of Liko Cave (Crete, Weesie, 1988) the figures drop to 20%. At the l'Alghero (Sardinia;

Malatesta & Suriano, 1970), to 28.6%. At Es Pouàs (Eivissa) to 42% (Sondaar et al., 1995) and at the Cova Nova (Mallorca) to 59% (Florit & Alcover, 1987a; McMinn & Alcover, 1992).

The lack of raptors and marine birds at the Moleta Cave is difficult to explain. They are well represented in other insular fossil sites of similar age and representative fossil record (e.g. Cova Nova, Es Pouàs, Liko Cave). This scarcity may be tentatively explained by the more forested environment at the Moleta Cave. This may have favoured a greater abundance of Passeriformes and nocturnal birds of prey, which agrees with the taphonomy of the cave. Mainly forest species were recovered (e.g. *Loxia curvirostra*, *Parus ater*, *Jynx torquilla*) but others may suggest the presence of wetlands (vgr. *Tadorna* sp., *Branta* cf. *bernicla*, *Porzana porzana*) and open areas (e.g. *Coturnix coturnix*, *Anthus pratensis*, *Alauda arvensis*). The combined presence of moist meadows and forests seems to have been frequent during the lattermost Pleistocene of other Mediterranean islands and of the mainland (Sánchez, 1996).

Another element related to the abundance of Passeriformes has to do with the aforementioned taphonomic processes. We believe that the origin of the deposition of microvertebrate remains is chiefly by bioaccumulation. Among the candidates we find *Athene noctua* and very especially *Tyto alba*, which may be the species responsible for the accumulation of remains of small birds through pellet deposition.

Some taxa at the Moleta Cave, such as *Turdus* and *Pyrrhocorax*, would need a more expanded discussion. They are highly representative of Upper Pleistocene avifaunas in the Western Mediterranean, and have also been recorded at the Cova des Moro, a site

partially coetaneous with the Moleta Cave. An approach to paleoecological and biogeographic aspects related to them can be found in the paper dealing with that cave (Seguí, 1997, in this volume).

Due to its rich paleornithologic record, the data from Moleta Cave reinforce the views on the mallorcan Upper Pleistocene (see Seguí, 1997, in this volume). The study of the island of Minorca may enable a full understanding of paleofaunistic trends of the Gymnesic subarchipelago during the late Quaternary.

### Acknowledgments

We thank Joan J. Fornós, Juan Carlos Rando, Lluís Fiol, Antònia Sans, Antoni Ginard and Enric Descals for their valuable contributions to this work, which is included in the DGICYT project (Ministerio de Educación y Cultura) PB 94-1175.

### References

- Adrover, R. 1966. Pequeño intento de lavado de las tierras de la cueva de Son Muleta y los resultados obtenidos. *Bol. Soc. Hist. Nat. Balears*, 12: 39-46.
- Alcover, J.A., Florit, F., Mourer-Chauviré, C. & Weesie, P.D.M. 1992. *The avifaunas of the isolated Mediterranean islands during the Middle and Late Pleistocene*. In: K. E. Campbell (eds.) *Papers in Avian Paleontology. Honoring Pierce Brodkorb*, 36: 273-283. Science Series. Natural History Museum of Los Angeles. Los Angeles.
- Alcover, J.A., Moyà-Solà, S. & Pons-Moyà, J. 1981. *Les quimeres del passat. Els vertebrats fòssils del Plio-Quaternari de les Balears i Pitiüses*. I. C. d. Natural. Memòries, 11. Editorial Moll. Palma de Mallorca. 260 pp.
- Bacher, A. 1967. *Vergleichend morphologische Untersuchungen an Einzelknochen des postkranialen Skeletts in Mitteleuropas vorkommender Schwäne und Gänse*. Universität München. München. 109 pp.
- Ballmann, P. & Adrover, R. 1970. Yacimiento paleontológico de la cueva de Son Bauzá (Mallorca). *Acta Geologica Hispanica*, 5: 58-62.
- Bate, D.M.A. 1928. Excavation of a Mousterian Rockshelter at Devil's Tower, Gibraltar. The animal remains. *Journal of the Royal Anthropological Institute*, 58: 103-110.
- Baumel, J.J., King, A.S., Lucas, A.M., Breazile, J.E. & Evans, H.E., 1979. *Nomina Anatomica Avium*. Academic Press. London.
- Blondel, J. & Frochot, B. 1976. Caractères généraux de l'avifaune de Corse. Effets de l'insularité et influence de l'homme sur son évolution. *Bull. Soc. Hist. Nat. Corse*, 619: 63-74.
- Blondel, J. 1982. Caracterisation et mise en place des avifaunes dans le bassin Méditerranéen. *Ecologia Mediterranea*, 8: 253-272.
- Blondel, J. 1987. *History and development of bird faunas in the Mediterranean region*. In: C. Mourer-Chauviré ed. *L'Evolution des oiseaux d'après le témoignage des fossiles*, 99: 231-238. Docum. Lab. Géol. Lyon. Centre National de la Recherche Scientifique. Lyon.
- Cramp, S., 1992. *Birds of the Western Palearctic. Handbook of the birds of Europe, the Middle East and North Africa*. Vol. 9. Oxford University Press. Oxford. 728 pp.

- Ferrer, X., Martínez Vilalta, A. & Muntaner, J. 1986. *Història Natural dels Països Catalans*, Vol. 12. Ocells. Enciclopèdia Catalana, S.A. Barcelona. 445 pp.
- Fick, O. K. W. 1974. *Vergleichend morphologische Untersuchungen an Einzelknochen europäischer Taubenarten*. Universität München. München. 93 pp.
- Fiol, Ll. 1996. Flora de les entrades de les cavitats de Mallorca. *Endins*, 20/ *Mon. Soc. Hist. Nat. Balears*, 3: 145-153.
- Fischer, K. & Stephan, B. 1974. Eine pleistozäne Avifauna aus der Ghar Dalam-Hölle, Malta. *Z. geol. Wiss. Berlin*, 2 (4) :515-523.
- Florit, X. & Alcover, J.A. 1987a. Els ocells del Pleistocè Superior de la Cova Nova (Capdepera, Mallorca) I. *Boll. Soc. Hist. Nat. Balears*, 31: 7-32.
- Florit, X. & Alcover, J.A. 1987b. Els ocells del Pleistocè Superior de la Cova Nova (Capdepera, Mallorca) II. *Boll. Soc. Hist. Nat. Balears*, 31: 32-44.
- Gargallo, G. 1991. Identificació del busqueret coal·larga (*Sylvia sarda balearica*). *A.O.B.*, 6: 35-42.
- GOB. 1996. *Anuari Ornitològic de les Balears*, 1995. Vol. 10. Palma de Mallorca. 144 pp.
- GOB. 1997. *Atlas dels ocells nidificants de Mallorca i Cabrera*. Consell Insular de Mallorca. Palma de Mallorca. 315 pp.
- Guerrero, V.M. 1996. El poblamiento inicial de la isla de Mallorca. *Complutum Extra*, 6 (I): 83-104.
- Howard, H. 1929. The avifauna of Emeryville Shellmound. *Univ. of Calif. Publ. Zool.*, 32 (1): 301-394.
- James, H. & Olson, S. 1991. Description of thirty-two new species of birds from the Hawaiian Islands: Part II. Passeriformes. *Ornithological Monographs*, 46: 1-88.
- Jánossy, D. 1983. Humeri of central European smaller passeriformes. *Fragmenta mineralogica et paleontologica*, 11: 85-112.
- Lambrecht, K. 1933. *Handbuch der Paleornithologie*. B. Edit. Berlin. 1024 pp.
- Lydekker, L. 1891. On Pleistocene bird-remains from the Sardinian and Corsican Islands. *Proc. Zool. Soc. London*, 3: 467-477.
- Malatesta, A. & Suriano, F. 1970. Avifauna Pleistocenica di Alghero (Sardegna). *Bolletino del Servizio Geologico Italiano*, 91: 149-158.
- Marcus, L. F. (in press). Variation in selected skeletal elements of the fossil remains of *Myotragus balearicus*, a Pleistocene bovid from Mallorca.
- McMinn, M. & Alcover, J.A. 1992. Els ocells del Pleistocè superior de la Cova Nova (Capdepera, Mallorca). III. Noves aportacions al registre. *Boll. Soc. Hist. Nat. Balears*, 35: 17-32.
- Miller, A.H. 1937. Structural modifications in the Hawaiian goose (*Nesochen sandvicensis*). A study in adaptative evolution. *University of California Publications on Zoology*, 42 (1): 1-80.
- Moreno, E. 1985. Clave osteológica para la identificación de los passeriformes ibéricos. I. *Ardeola*, 2 (32): 295-377.
- Moreno, E. 1986. Clave osteológica para la identificación de los passeriformes ibéricos. II. *Ardeola*, 1-2 (33): 69-129.
- Moreno, E. 1987. Clave osteológica para la identificación de los passeriformes ibéricos. III. *Ardeola*, 2 (34): 243-273.
- Mourer-Chauviré, C. 1975. Les oiseaux du Pléistocène Moyen et Supérieur de France. *Documents des Laboratoires de Géologie de la Faculté de Lyon*, 64 (1-2): 1-624.

- Mourer-Chauviré, C., Moyà, S. & Adrover, R. 1977. Les oiseaux des gisements quaternaires de Majorque. *Nouv. Arch. Mus. Hist. Nat. Lyon*, 15: 61-64.
- Olson, S. & James, H. 1991. Description of thirty-two new species of birds from the Hawaiian Islands: Part I. Non-Passeriformes. *Ornithological Monographs*, 45: 1-88.
- Rando, J.C. 1995. Presencia de restos de pigargo (*Haliaeetus* sp.) (Aves: Accipitridae) en yacimientos paleontológicos de Fuerteventura. *Vieraea*, 24: 65-69.
- Rando, J.C. & López, M. 1996. Un nuevo yacimiento de vertebrados fósiles en Tenerife (Islas Canarias). *Proc. IX. Intern. Symp. Vulcanospeleology*: 171-173.
- Reumer, J.W.F. 1982. Some remarks on the fossil vertebrates from Menorca, Spain. *Proc. Konink. Ned. Ak. Wetenschappen, ser. B*, 85(1): 77-87.
- Sánchez, A. 1996. Aves fósiles del Pleistoceno Ibérico: rasgos climáticos, ecológicos y zoogeográficos. *Ardeola*, 43(2): 207-219.
- Seguí, B. 1997. Avifauna fòssil del jaciment plistoholocènic de la Cova des Moro (Manacor, Mallorca). *Boll. Soc. Hist. Nat. Balears*, 40.
- Sondaar, P.Y., McMinn, M., Seguí, B. & Alcover, J.A. 1995. Interès paleontològic dels jaciments càrstics de les Gimnèsies i Pitiüses. *Endins*, 20/Mon. Soc. Hist. Nat. Balears, 3: 155-170.
- Stork, H.J. 1967. Morphologische die Untersuchungen an Drosseln. Eine analyse von Anpassungsstrukturen im Körperbau von sechs europäischen Arten der Gattung *Turdus*. *Z. F. Wissenschaft. zool.*, 178: 72-185.
- Waldren, W.H. 1980. *Radiocarbon determination in the Balearic Islands. An inventory 1962-1981*. The Donald Baden-Powell Quaternary Research Centre, Pitt Rivers Museum. Oxford.
- Waldren, W.H. 1982. Balearic Prehistoric Ecology and Culture. The excavation and study of certain caves, rock shelters and settlements. *BAR International Series*, 149 (i-iii): 1-773.
- Weesie, P.D.M. 1988. *The quaternary avifauna of Crete, Greece. Paleo-vertebrata*, 18 (1): 1-94.
- Woolfenden, G.E. 1961. Postcranial osteology of the waterfowl. *Bull. Florida State Museum, Biol. Sci.*, 6: 1-129.